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A study of concrete mixers

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A STUDY OF CONCRETE MIXERS

BY

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This is to certify that the thesis of CHARLES ARTHUR NYE entitled A Study of Concrete Mixers is approved by me as meeting this part of the requirements for the degree of Bachelor of Science in Civil Engineering.

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A STUDY OF CONCRETE MIXERS.

Concrete consists of cement mortar in which are imbedded pebbles or pieces of broken stone. Its use has been known for ages, and it needs no introduction to the building world. For many years wood has taken, in part, its place as a building material, but the fast destruction of the forests, the scarcity of wood, and its steady increase in price have forced the building world to introduce better and cheaper building materials.

Concrete is indestructible, economical, and fireproof, and is the only material known that does not deteriorate with age and exposure. The railroads and the United States government are using concrete almost entirely for every class of work in which stone and wood were formerly used. In the construction of buildings, it is fast becoming very popular, and in street and sidewalk construction it is used almost exclusively. The increase in the amount of cement manufactured, together with its decrease in cost, has helped to promote the use of concrete.

Plain concrete is practically artificial stone, and if it is well made, it has all the properties of good stone. Furthermore, its great value as a building material lies in the fact that it can be reinforced with steel. This combination constitutes a form of construction possessing to a large degree the advantages of both materials without their disadvantages.

Since concrete has become so important a building

material it is essential that the best concrete which it is possible to make should be used. The best and strongest concrete is that in which the cement fills all the voids of the coarser aggregate. To obtain this concrete the cement must be thoroughly mixed with the other ingredients.

The mixing of concrete, until recently, was done by men who turned the ingredients over and over on a water-tight platform. It required several turns before it was well mixed. This method was slow and very laborious as well as expensive. The demands for rapid and economical handling of the greatest of building materials have caused the invention and rapid improvement of modern and desirable concrete mixers. It led at first to the design of many mixers of the batch type. Many of the earlier of these mixed concrete well, but in so doing wasted rather than saved time. Many of them have now been improved so that they will mix well and rapidly large quantities of concrete.

While the batch mixer was being improved, the continuous mixer was invented. The greatest objection to this type of mixer at first was that an exact proportion of ingredients could not be obtained, while the mixing of them was easily perfected. This type of mixer has been improved until more exact proportions can be obtained by it than by the batch mixer.

In general there are three methods used in the mechanical act of mixing concrete. The same principles are applied to either a batch or a continuous mixer. The first is a

crowding or rolling motion of the aggregate, the second is a lifting and dropping of the aggregate, and the third is a puddling or cutting of the aggregate. Of the three types, the first is the least desirable. The first concrete mixers were made to follow one of these principles, but now the mixers usually have a combination or modification of the three principles.

The action of the first principle is a rolling over and over of the concrete upon itself in the mixing drum or cylinder. Examples of machines using this principle are the "Snell" in the batch mixer, and the "Little Giant" in the continuous mixer. Mixers using this principle were so unpopular that the manufacture of several was discontinued, while others were modified by placing blades inside of the drum. The objection was that the mass in rolling formed into balls and there was no violent action to break them up; hence poor concrete was made.

The action of the second principle is that of shelves inside of the drum which repeatedly lift and drop the aggregate. Examples of machines using this principle are the "Clover Leaf" in the batch mixer, and the "Coltrin" in the continuous mixer. This principle of mixing is the best for thoroughness, but it requires more power to operate it, and the revolving of the drum is also objectionable.

The third principle is that of the stationary drum with revolving paddles or blades inside of it, which cut up or puddle the aggregate. The "Foote" Continuous Mixer is the

best known of this type of mixer. While this was at first a distinct type of mixer, nearly all mixers that have blades or obstructions on the inside of their drums have gotten their idea from this principle. This is, in the author's opinion, the most desirable type of a continuous mixer, as the speed of the paddles governs the capacity rather than the size of the mixing drum. The principle objection is a prejudice that the proportions of mix are not precise; but with most mixers this is prejudice only. Theoretically it is more precise than any other, as in all modern continuous mixers the feed is automatic, thus doing away with the "human equation".

In the operation of a mixer the method of charging is of prime importance. Two things are considered: first the precision of proportioning, that is, the method of feeding; and second, the rapidity of feeding. Most batch mixers are considered more accurate in the proportioning of the aggregate than continuous mixers. In practice they are not, as most of them are measured "by hand", while nearly all continuous mixers are mechanical measuring. Most continuous mixers are charged from the hopper, which is kept constantly full, the material being shoveled from the ground to the hopper; therefore, the lower the charging hopper, the cheaper it is to feed. A few inches in the height of the hopper makes a great economic difference. But on the other hand, a mixer with a very low charging hopper may have a discharge too low to dump into a conveyance.

A good mixer is one that mixes concrete thoroughly and economically. If a batch mixer, it must have a drum so shaped, or with wings so arranged, that it will mix the ingredients thoroughly. The feed hopper must be low; the source of power must be sufficient to run under maximum conditions, and the gearing must be so constituted and arranged as to stand rough usage. If a continuous mixer, it must have an exact proportioning device, low feed hopper, good mixing shaft, sufficient power, and strong gearing. Besides having the above named qualifications, they must be so constructed as to be simple, easily repaired, compact, and easily cleaned.

It is a very difficult task to collect data on concrete mixers with respect to the output of the machine, for the data should be taken when the machine is running under good conditions. To do so, a machine must be so located that the materials are easily accessible , the place of depositing the concrete near and large enough to place the concrete without the loss of time, and an average number of laborers should be employed. The tabulated data used are those obtained from many contractors and engineers, and were taken when the machines were working under good conditions.

The method of treating this thesis is to make a comparison of several different mixers of the two different types. This comparison will show the relative efficiencies of the mixers. Also a comparison of the first costs of the mixers will be shown.

As shown by the succeeding table, the writer has only made a comparative investigation of twelve mixers, six batch mixers and six continuous. This was done because they are representative types of the various principles and because they are used the most. Therefore, valuable data were more easily obtained of them.

The data which are valuable in investigating a concrete mixer are those which are taken when the machine was actually mixing concrete. The data thus obtained will vary and can only be used when the conditions are good. That is, the ingredients should be convenient, and the concrete should be placed as fast as it is made. These conditions will vary with different kinds of work, and it is therefore essential to get data from as many sources as possible.

The following list shows the different mixers that the writer has considered. The twelve investigated are representative types of the different principles used in mixing concrete. Furthermore, they seem to be the most successful, as it was found that the contractors interviewed used these machines the most, but some used other machines which seemed to give good satisfaction.

LIST OF CONCRETE MIXERS

Batch

1. Chain Belt
2. Chicago Cube
3. Chicago Concrete Machinery Co.
4. Clover Leaf
5. Eclipse
6. Fillmore
7. Foote
8. Gauntt
9. Hains
10. Hough
11. Marsh Capron
12. Marsh Dexter
13. McKelvey
14. Miles
15. Milwaukee
16. Polygon
17. Ransome
18. Smith
19. Universal

Continuous

1. Advance
2. Bolte
3. Century
4. Coltrin
5. Eureka
6. Fillmore
7. Foote
8. Gauntt
9. Hartwick
10. Kent
11. Little Giant
12. Miles
13. Miracle
14. National
15. New State
16. Polygon
17. Svenson
18. Systematic
19. U. S. Continuous

BATCH MIXERS

Batch mixers are those that mix a quantity of concrete at a time, and then this concrete is removed, the machine recharged, and mixed again. There are many different types. Most machines mix concrete by a motion of the mixing barrel, while some few move the ingredients of the concrete.

Of those that mix the concrete by the revolving of the barrel about an axis, there are many shapes and kinds. Some are cylindrical and some are cone-shaped. These have a series of blades which tend to mix the ingredients. Then there are the Clover Leaf, Chicago Tube, and octagonal-shaped mixers which are so shaped that the mixing is done entirely by the revolving of the barrel.

Of those that mix the ingredients by moving them and not the mixing barrel, the gravity mixer is the only example. It is so constructed that as the material falls through it, it is well mixed.

The power for the rotating mixers is either furnished by gas or steam engines, while those that do not move need no power.

CONTINUOUS MIXERS

As the name implies, a continuous mixer is one that mixes concrete continuously. To do so, this machine

must consist essentially of four parts: feed hoppers, automatic proportioning and feeding device, mixing device, and some means of power.

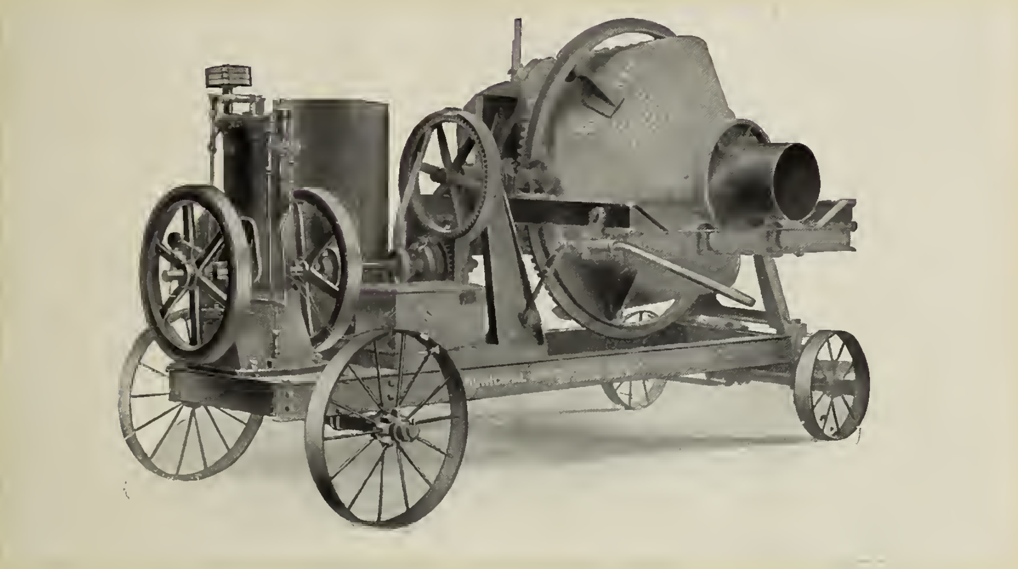
The feed hoppers consist of three metal boxes so placed as to be convenient for the reception of materials and also for emptying into the feeding devices.

Automatic feeders and proportioning devices are many, though there are only a few principles , and the many mixers embody only variations of these. They consist of: First, a conical, graduated, worm-feeding device. The proportioning is obtained by varying the speed of the worm and the size of the openings in the feed hoppers. Second, an endless conveyor-belt which revolves under the hopper so that the material falls upon it through adjustable openings which are graduated so as to give any proportion. Third, a pocket device made up of two sets of cupswhich are fed from the hoppers. These cups are arranged so that one fills while the other empties, and the graduation of the openings through which the material flows regulates the proportion.

The mixing device is some kind of a drum or cylinder which is placed at varying inclinations up to twenty-two degrees. The concrete is mixed in this drum by means of paddles or a rotating mixer. It is also wet while in this drum or cylinder by a sprinkling device.

The power may be either gasoline, steam, or hand power.

THE CHICAGO CUBE MIXER.

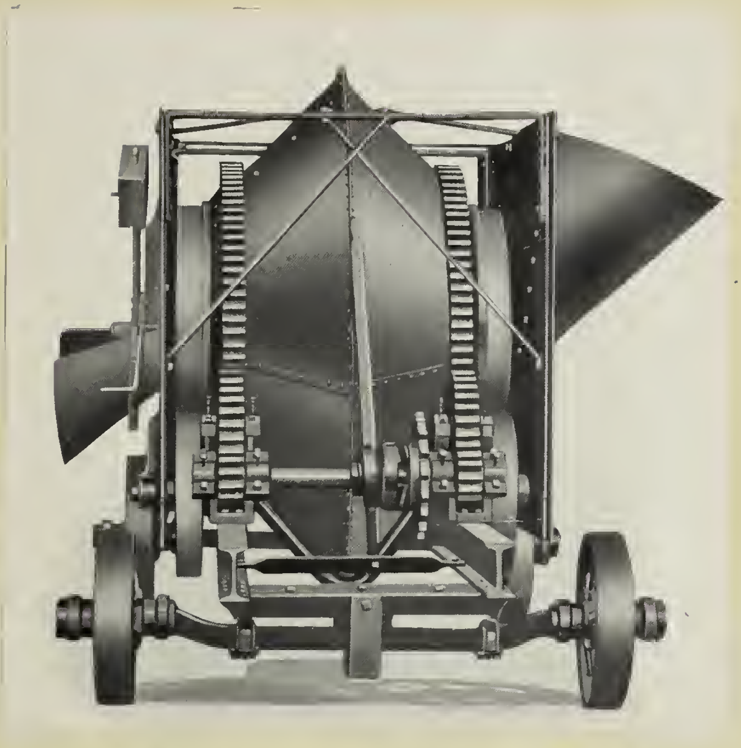


The Chicago Cube Mixer is of the batch type. The barrel is a plain cube, rotated in a diagonal direction, and each side takes the place of paddles or buckets. It is easily charged, and the ingredients are mixed by revolving the barrel. It is run by gasoline or steam power. The gearing is entirely of cog-wheels, which is weakly connected to the barrel. The concrete is discharged by tilting the barrel.

THE CLOVER LEAF BATCH MIXER.

The Clover Leaf Batch Mixer is of the revolving drum type. The drum consists of three involute curves so arranged that a section through the center looks like a clover leaf. It is very simple in construction and is run by steam or gasoline transmitted by cogwheels so that it stands rough usage. It mixes thoroughly, as the curves tend to turn the material completely three times in each revolution of the drum. The concrete is removed by tilting the drum.

THE FOOTE MIXER.



The mixing drum of the Foote Batch Mixer is in the form of a double cone put together at an angle of 45 degrees. It is set into cast iron heads. On these heads are cast drum gears on which the drum revolves. Wings are riveted to the inside of the drum, which, in combination with the shape of it, do the mixing when the drum is in motion. The power is steam or gasoline transmitted by cogwheels. It is a non-tilting machine, equipped with a rotary discharge chute which will discharge any portion of a batch. This allows the drum to be set low and has therefore a low feed hopper.

THE HAINS MIXER.

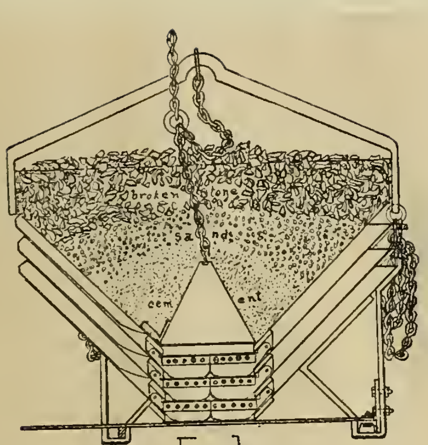


Fig 1

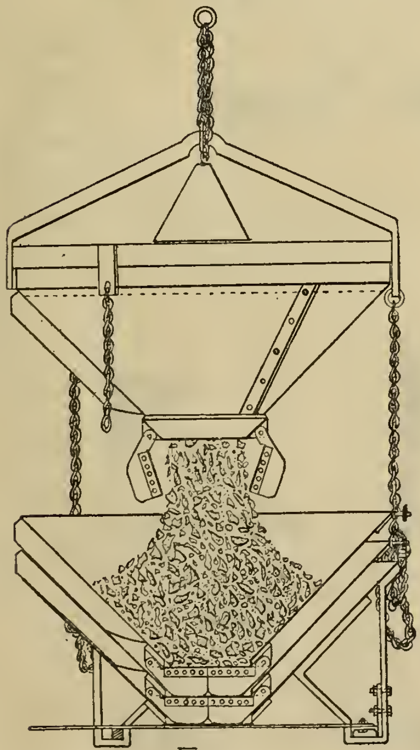


Fig 2.

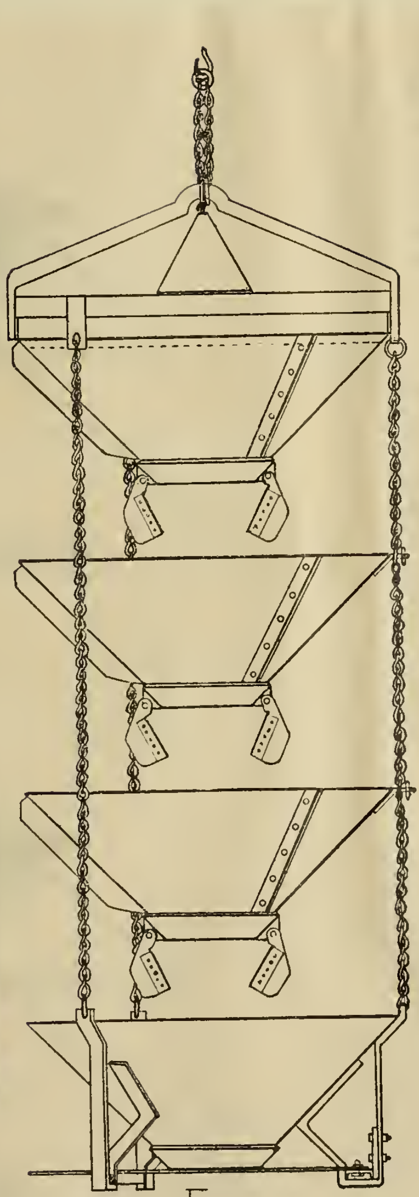


Fig 3

The Hains Gravity Mixer is of the batch type. The mixing is done entirely by the falling of the ingredients. It consists of four conical hoppers chained together. Each one has a drop bottom which opens automatically when the hopper is full. The ingredients are first put in the top hopper; when full the door opens and they fall into the hopper below and so on. When the bottom is opened the ingredients leave the hopper, not in a bunch, but by first drawing out the center, then the outside materials roll down from the top, thus partially mixing the materials in the hopper. This is due to the conical shape of the hoppers.

THE RANSOME BATCH MIXER.

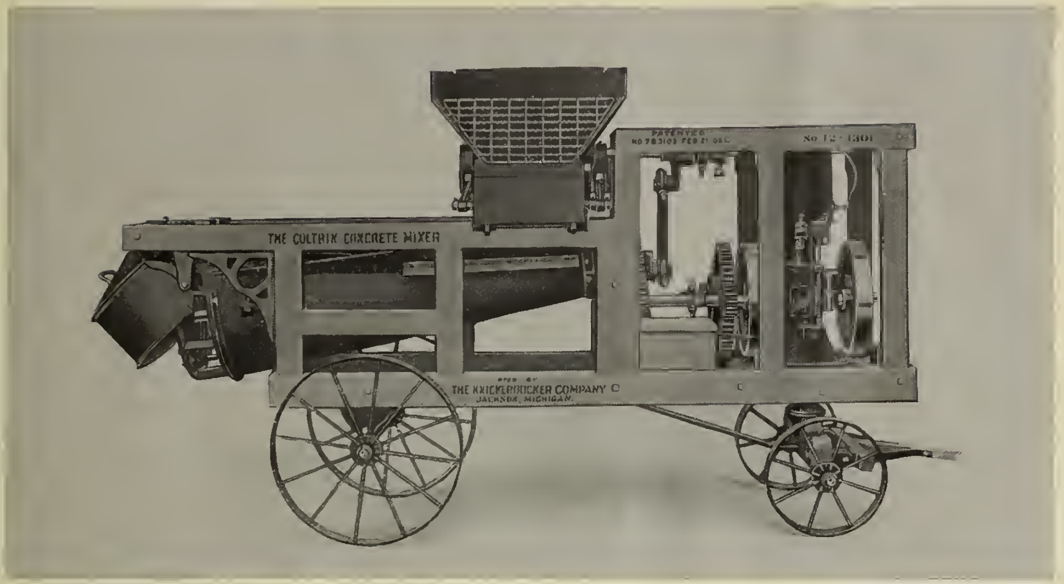
Figure 1036

The Ransome Batch Mixer consists of a cylindrical drum, fitted with cast traction rings, which revolve on four rollers. There is a series of blades riveted in this drum which do the mixing when the drum is in motion. The power is steam or gasoline and is transmitted through cogwheels. The concrete is discharged by tilting the chute, which is so arranged in the drum as to catch the material when it is tipped.

THE SMITH MIXER.

The Smith is a batch mixer of the rotating drum type. The drum consists of two steel cones riveted to a central ring. On the inner surface of this drum are riveted blades which are set at an angle to the central axis of the drum, so that when the drum is revolved these blades create a movement among the ingredients which mixes them all together. The power is usually steam, and it is connected by a gearing of cogwheels. The concrete is discharged by tilting the drum.

THE COLTRIN MIXER.



The Coltrin Continuous Mixer has three hoppers placed over the mixing cylinder. The middle hopper is the one for cement. The feed device consists of three pockets for automatically proportioning rock, sand, and cement. This proportioner works by a pitman on the drive end of the cylinder shaft, which is connected with the feeder in such a manner as to form a half-jaw clutch. The pockets on each side are operated by one sliding part which moves forward and back on rollers acting as a plunger for delivering the ingredients. The materials are mixed by a revolving ribbed cylinder. The power used is gasoline transmitted by cogwheels.

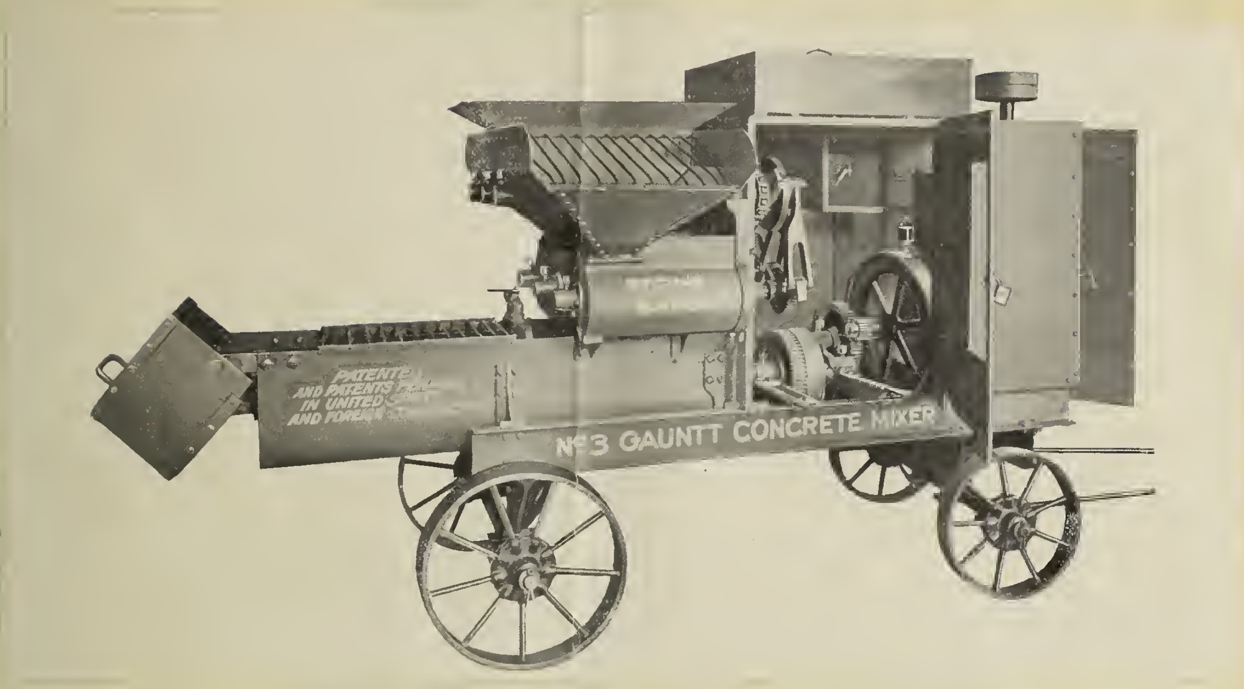
THE FILLMORE CONCRETE MIXERS.

The Fillmore Continuous Mixers consist of three parts: feed hopper, automatic proportioning device, and mixing cylinder. The sand and stone hoppers are on opposite sides of the machine, and are placed very low. The cement hopper occupies a position in the center. The proportioning is obtained by screw feeds. A change of proportion is obtained by a change of speed. The material is mixed in the cylinder by the revolving of a square shaft on which are bolted, in spiral form, plow shaped shovels. The power is steam or gasoline.

THE FOOTE MIXER.

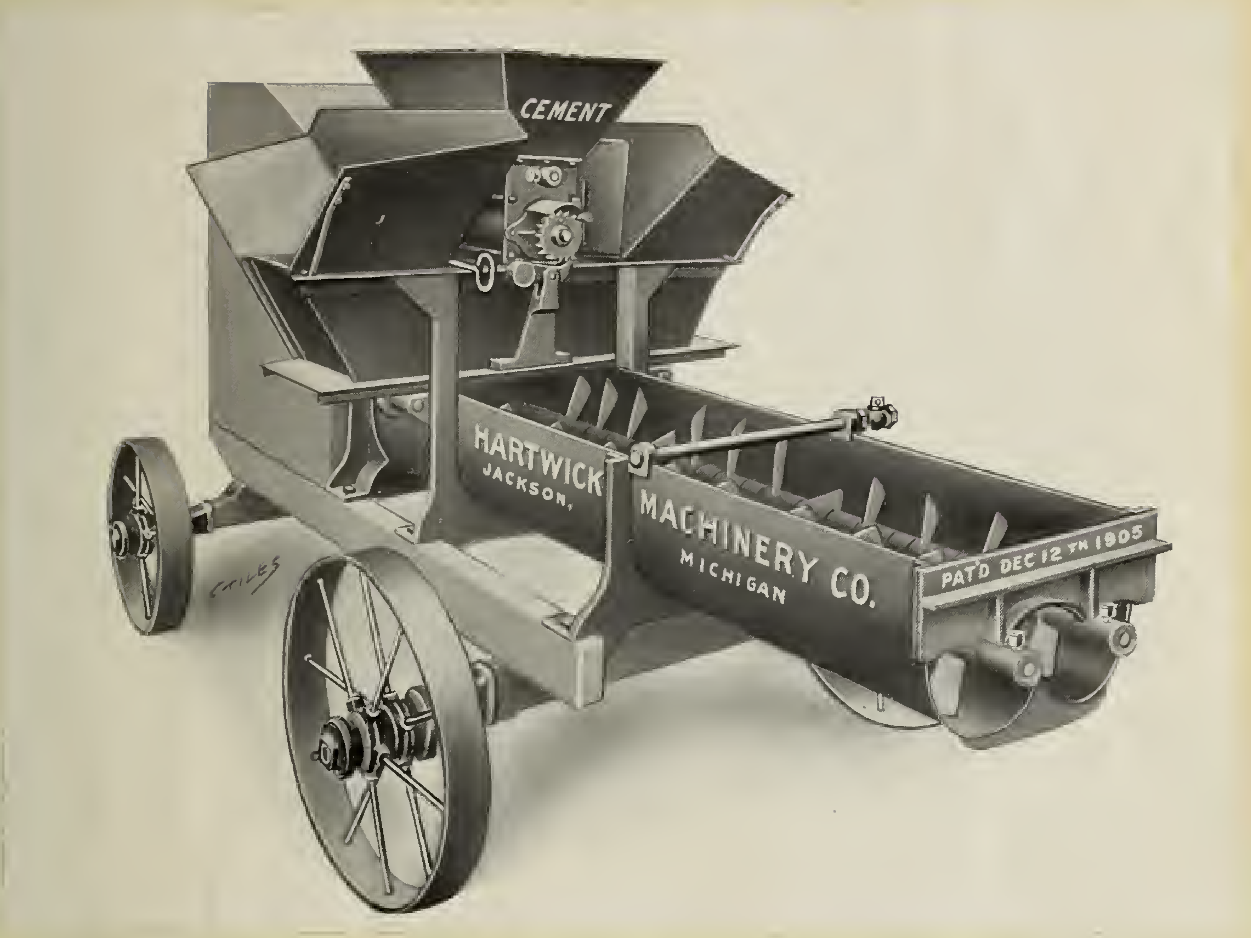
The Foote Continuous Mixer consists of three low-feed hoppers, automatic proportioning device, and mixing barrel. The two outside hoppers are for sand and gravel, and the center one is for cement. The measuring is done by heavy feed worms, revolved at required speeds by interchangeable sprockets. These worms are located at the bottom of the hoppers, at nearly the same level with the bottom of the mixing drum. Their location and positive operation make it possible to equip the mixer with such low hoppers. The mixing is carried on in the drum by the revolving of the wings for that purpose. The concrete is wet by an automatic sprinkler. The power is gasoline or steam, transmitted by a chain belt.

THE GAUNTT MIXER.



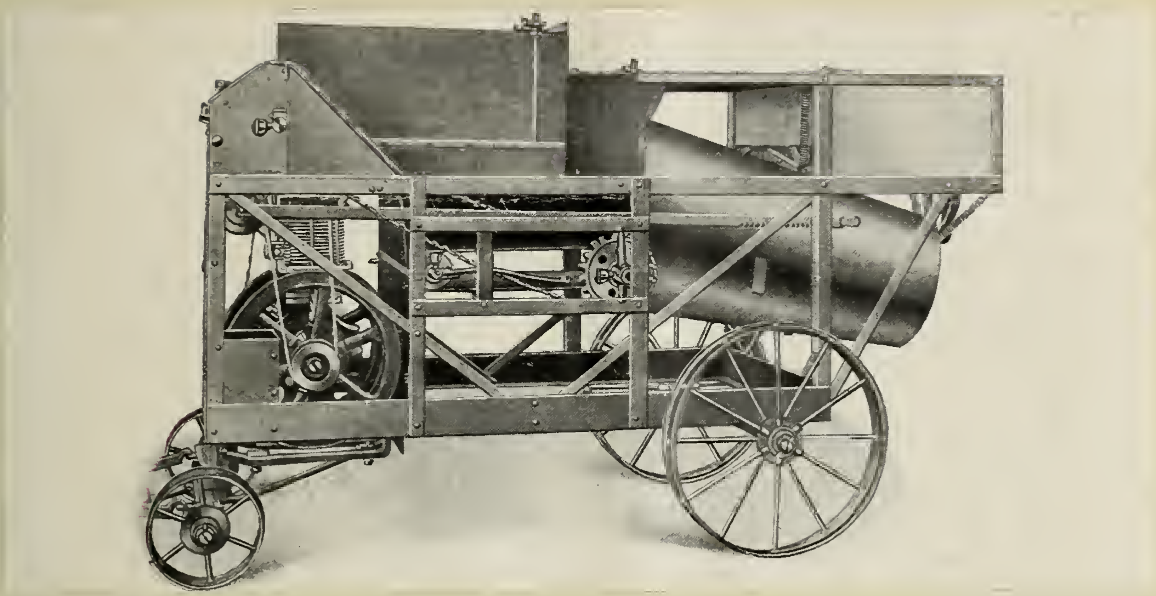
The Gauntt Continuous Mixer is built of iron and steel, with dust protected rollers. It consists mainly of: feed hoppers, automatic proportioning device, and mixing cylinder. The feed hoppers are large and low. The sand and stone hoppers are placed on opposite sides of the machine, while the cement hopper is between them. At the bottom of these hoppers are the usual feed worms. The proportioning is regulated by changing the speed. The materials are mixed by wings which are mounted on a square steel shaft. The power used is gasoline transmitted by cogwheels.

THE HARTWICK MIXER.



The Hartwick Continuous Mixer consists of three feed hoppers, of which the middle one is for cement. The feeding apparatus for sand and stone consists of a flat steel plate forming the bottom of the hopper and having a reciprocating motion. The cement proportions are obtained by means of a rotary cup feed, over which is placed a slide. By changing the position of the slide, any desired proportion may be fed. The mixing is done in a Double Mixing Trough. This trough has two sets of mixing flights which revolve in opposite directions. The power is either steam or gasoline.

THE LITTLE GIANT MIXER.



The Little Giant Continuous Mixer has three feed hoppers: one for sand, one for gravel, and the other for cement. The ingredients are automatically proportioned by the adjustable gates. The flow is kept constant by worm agitators. It is then carried by an endless belt to the upper end of the mixing drum, which mixes the ingredients by the rotary action of the drum. The mixture is wet, when two-thirds of the way down the drum, by a spray. The power is gasoline transmitted by chain belts. This mixer is small and easily transported, and is excellent for street work.

TABLE OF COST DATA.

BATCH.

Name of Mixer.	No.	Size of Batch Yds.	Proportion of Mixture	Cu. Yds. Per Day of 10 Hrs.	Number of Men	Cost of Mixer.	Depreciation Per Hour.	Interest on Cost Per Hr.	Cost of Mixing Concrete Per Hr.
Chicago Cube	14	½	1-3-6	140	24	$815.00	$0.102	$0.036	$0.353
Clover Leaf.	15	"	1-2½-5	120	20	850.00	0.106	0.032	0.345
Foote.	6	"	1-3-6.	125	18	1300.00	0.163	0.049	0.305
Hains.		"	1-3-6	200	20	550.00	0.069	0.021	0.204
Ransome.	14	"	1-2½-5	125	25	900.00	0.113	0.038	0.412
Smith.	2	"	1-3-6	120	24	875.00	0.109	0.032	0.412

CONTINUOUS.

Coltrin.	14		1-3-6	125	16	400.00	0.050	0.015	0.258
Fillmore	12		1-2½-5	120	15	975.00	0.123	0,037	0.263
Foote.	3.		1-3-6	160	18	1375.00	0.172	0.052	0.233
Gauntt.	3.		1-3-6	120	14	700.00	0.087	0.026	0.242
Hartwick.	3.		1-3-6	120	14.	425.00	0.053	0.016	0.243
Little Giant.	C.		1-2-5	140	18.	500.00	0.063	0.019.	0.263

The table shows the size and cost of each mixer, the estimated amount of concrete that each will mix per hour, the interest on the cost of each mixer per hours run, the estimated amount of depreciation per hour's run, the number of men employed, and the cost of mixing per yard.

The depreciation is calculated on the basis that the mixer deteriorates twenty percent each year, and that the machine is used for eight months, of twenty ten-hour days, each year. The interest on the cost price is taken at six percent per annum.

The data used were those obtained from many contractors. The data for each make of mixer was obtained from several contractors on foundation, bridge abutment, retaining wall, reinforced concrete arches, buildings, and street work. In every case the output of the same mixer was practically the same. The number of men shown in the table is the number required to feed the mixer and to take the concrete to the forms. It is assumed that the cost of power was the same for each mixer and it has been neglected in the computations of the cost of mixing per yard. This may be estimated at about four cents per cubic yard. The price paid for labor is taken at twenty cents per hour. The output is taken as the average output of the mixers on the various kinds of work.

It is impossible to determine just what mixer is the best because some makes of mixers are better adapted to mixing concrete for certain kinds of work than others. Theoretically the best mixer is the simplest mixer, but those with the plain

mixing drum, as the Chicago Cube and the Clover Leaf, are weakly constructed and the mixing of the ingredients causes either eccentricity or extra impact stresses. Therefore, the writer, in order to do justice to each mixer, can only, from the material at hand, discuss the mixers that are best adapted to the various kinds of work.

The Continuous Mixers differ from the Batch Mixers in that they are more nearly on an equal basis. And it is simply a question as to which make of mixer has the best qualities. That mixer should have low feed hoppers, the screw type of automatic proportioning device, and a thorough mixing device. Besides having these properties, it should be simple, strong, and easily cleaned.

The Chicago Cube Mixer.

The Chicago Cube Mixer is one that mixes the ingredients by folding them first to one side of the barrel and then to the other. This motion is produced by the revolving of the barrel and by its cubical shape. The machine is compact, easily fed and easily discharged, but its mechanism is complicated and it easily gets out of repair. It mixes concrete rapidly and thoroughly and is easily cleaned, as there are no obstructions in the barrel. The greatest objection to this machine is that the motion of the ingredients creates a lateral jolt, which is hard on the machinery. It empties by tilting, which also produces

a strain and requires extra mechanism.

The Clover Leaf Mixer.

The Clover Leaf is a mixer that cuts through and doubles over the ingredients three times in each revolution. This motion is produced by the shape of the mixer. The "involute curve" shape of each lobe eliminates all possibility of rolling. The barrel is revolved by a spur gear. The mechanism is simple, thus eliminating many break downs. One objection is that in lifting the ingredients in a curve the centre of gravity of the loaded machine is thrown away from the axis of the barrel, thus causing extra strain and wear on the bearings. This machine mixes concrete thoroughly and rapidly and is easily cleaned, as there are no obstructions in the barrel. It empties by tilting, which strains the machinery and also requires extra mechanism.

The Foote Batch Mixer.

The Foote Batch Mixer is one whose drum is made of two inverted cones. This shape of drum, together with the mixing wings, lap and cut the ingredients when the drum is in motion. The drum is turned by two spur gears, one on each side of the barrel. The gearing is strong and stands a large amount of hard usage. One of the greatest advantages of this machine is that it empties without tilting; this is done by means of an

unloading skip, which will remove any or all of the batch of concrete. This machine mixes concrete rapidly and thoroughly. It is fairly easy to clean.

The Hains Mixer.

The Hains Mixer is one that mixes the ingredients by the force of gravity. In falling from one hopper to the one below the ingredients are rotated and mixed while the mixer remains stationary. The mixer has a very large capacity and also mixes concrete well. It is an excellent mixer where there is room and favorable conditions under which to operate it. The best conditions for this mixer are those where there is a large amount of concrete to be made at an elevation below the materials of construction, which is greater than the length of the mixer. The repairs of this mixer are very light, as there is no motion of the mixer and practically no wear. It is easily cleaned. No power is required to operate it.

The Smith Mixer.

The Smith Mixer is one whose drum is composed of two inverted cones, which are equipped with a series of mixing blades. The rotating of the barrel, together with the blades, lap and cut the ingredients so that they are mixed rapidly and thoroughly. The barrel is rotated by power transmitted by a spur gear in the center of the barrel. The mechanism is simple and strong so that it stands rough usage. The mixer is emptied by tilting. It is easily cleaned.

The Ransome Mixer.

The Ransome Mixer is a batch mixer with a cylindrical barrel which is equipped with mixing wings. When the barrel is rotated the wings cut and mix the ingredients thoroughly and rapidly. The barrel is turned by a spur gear which is placed near one end of the barrel thereby producing considerable eccentricity. The gearing is stable and strongly connected. The mechanism is simple and strong so that it stands hard usage. The mixer empties by means of a tilting chute. This eliminates a great amount of hard wear from the mixer. The machine is compact and easily moved. It can be cleaned rather easily.

The Coltrin Mixer.

The Coltrin Continuous Mixer has three feed hoppers which are placed very high. The automatic proportioning device is of the pocket type, which works well as long as the crushed stone or gravel is of uniform size. The ingredients are mixed in a cylinder by a revolving ribbed cylinder. This is a very good type of mixer. The ingredients are wet after they are about one half way down the mixing cylinder. The machine is driven by a spur gear whose mechanism is simple and strong. The greatest objections to this mixer are its high feed hoppers and the pocket proportioning device.

The Fillmore Mixer.

The Fillmore Continuous Mixer has three feed hoppers which are placed low. The automatic proportioner is of the screw type. The ingredients are mixed in the cylinder by revolving the paddles or blades and are wet when one-half the way down the cylinder. The machine is driven by a spur gearing which is strong and simple. The greatest advantages of this mixer are its low feed hoppers and screw proportioning device. Its disadvantages are that it does not mix thoroughly and that it occupies a large amount of space.

The Foote Continuous Mixer.

The Foote Continuous Mixer has three feed hoppers which are placed very low. The automatic proportioner is of the screw worm type. The ingredients are mixed by a set of revolving wings and are wet when one-half the way down the cylinder. The machine is driven by chain belts, which are strong and will stand hard usage. The advantages of this machine are its low feed hoppers, screw proportion device, its compactness, and that it is easily cleaned.

The Gauntt Mixer.

The Gauntt Continuous Mixer has three feed hoppers which are placed fairly high. The automatic proportioning device is a combination of the slot and screw type. The mixing of the ingredients is done in a mixing trough by rotating pad-

dles. It is wet when about two-thirds of the way down the trough. The machine is driven by chain belts. The mechanism is strong but somewhat complicated. The mixer is compact, taking up only a small space, and is easily moved. It is easily cleaned. The greatest objection to this machine is the height of its feed hoppers.

The Hartwick Mixer.

The Hartwick Continuous Mixer has three feed hoppers which are placed rather high. The automatic proportioning device is of the slot type. The ingredients are mixed in a double mixing trough by two sets of revolving paddles and wet when one-third of the way down the trough. It is driven by spur gears which are strong and simple. It is compact. The greatest advantages of this machine are its thorough mixing device, its strenght, and compactness. The objections are its high feed hopper and slot proportioning device.

The Little Giant Mixer.

The Little Giant Continuous Mixer has three feed hoppers which are placed very high. The automatic proportioner is of the screw type. The ingredients are mixed in a rotating drum, which is inclined at an angle of about twenty degrees. By the slope of the drum, gravity is used to save power. The drum is turned by chain belts, the mechanism of which is simple

and strong. The greatest advantages of this machine are that it requires a small amount of power to operate it, and that it is light and easy to move. It is easily cleaned. The greatest objection is the height of its feed hoppers.

Batch Mixers.

From the discussion of the construction of the various types of batch mixers, the Foote Batch Mixer is, in the opinion of the writer, the nearest to an ideal mixer, as its double cone-shaped mixing drum, together with the mixing wings, will mix the ingredients thoroughly and rapidly. The construction is simple and strong, and it is also compact.

For sewer work, deep foundation work, and other similar work where the concrete has to be lowered below the surface of the earth, the Hains Gravity Mixer is evidently the best, for it requires no power, it mixes concrete thoroughly and rapidly and is simple, durable, and easily cleaned. From the table it appears that the Hains Gravity Mixer also mixes concrete the most economically where the conditions are favorable for it.

Continuous Mixers.

From the discussion of the continuous mixer it would appear that the Foote Continuous Mixer is the best in construction, for it has low feed hoppers, an automatic screw proportioning device, and good mixing cylinders. It is strong, simple, easily

cleaned, easily moved, and compact.

An examination of the table shows that even though the first cost is the greatest, the Foote Continuous Mixer mixes concrete most economically. This tends to show that the above principles are the most essential properties of a continuous mixer.

In general, the writer has found that the ratings placed upon the mixers by the makers are about correct.

It has also been found in the investigation of the many continuous mixers that most of them will mix concrete thoroughly. The question is to get a mixer that will give accurate proportions and mix the ingredients economically. Also, it would seem that the screw type of automatic proportioners is the best. Another very important factor is that of having low feed hoppers which decrease labor.

The Batch Mixers will in general mix the ingredients thoroughly and rapidly. It is essential that they be built simply and strongly. The greatest objection to a batch mixer is that it requires more labor to keep it running to its full capacity.

In comparing the cost of operation of the two types of mixers for general concrete work, the continuous mixers appear to be more economical; though for special work the Hains Gravity Mixer is more so. The quality of concrete mixed by each type of machine is of prime importance. The conclusion on this

feature is that under good conditions the continuous mixer will produce better concrete than the batch mixer, because with the batch mixers the personal equation of the laborers has to be considered. That each laborer will, unless he has a measure of exact size, put too much or too little sand and gravel or crushed stone in each batch to be mixed. Then occasionally a batch of concrete will be undermixed. While with the continuous mixers, by keeping the feed hoppers full of ingredients, the machine will give continuously the exact proportion for which the proportioner is set. It may be set for any proportion on the good up-to-date mixers. Furthermore, the ingredients are all mixed an equal amount in going through the mixing trough. As a result the concrete is consistent and of the best quality. Therefore, the writer recommends a continuous mixer as a type of mixer that will produce the best concrete and do it the most economically.